A DISTRIBUTED REAL-TIME HURRICANE WIND ANALYSIS SYSTEM

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1. INTRODUCTION

The Hurricane Research Division (HRD), within the National Oceanic and Atmospheric Administration (NOAA), has been producing real time analyses of tropical cyclone surface wind observations with the help of platform-dependent software, tied to a specific filesystem in which data integrity, proper security and Internet deployment are difficult to achieve (Amat, 1998). The incorporation of significantly updated software engineering methodologies and technologies: the full engagement of Object Oriented development with Java as the main programming language, the extensive use of an object-relational database management system, and the involvement of distributed objects makes the new client-server application (H*WIND) portable across multiple platforms and accessible over intranet/Internet connections, with major improvements on data storage and retrieval. Since the product of these analyses is aimed to aid hurricane and storm surge specialists at the National Hurricane Center (NHC), this application, for example, could potentially become an operational tool.

Essentially, the process sequence to obtain a surface wind analysis, as explained by Powell, et. Al. (Powell, 1997), remains the same; but with added flexibility. The near real time observations are gathered from as many platforms as possible (Air Force/NOAA reconnaissance aircraft, GPS dropsondes, CMAN, ships, buoys, METAR, SSMI, ERS2, GOES, etc.), adjusted to a common height, exposure and time period, and then input to a database, rather than flat files. Immediately, this opens endless possibilities for multi-user sharing and querying of this ever increasing repository by any interested party. H*WIND has been designed to perform quality control and analysis on any given basin: Atlantic, Eastern, Central, Western and South Pacific and Indian.

2. FUNCTIONAL DESCRIPTION OF H*WIND

The front end of the application is a graphical user interface (Quality Control subsystem) which the scientist uses to retrieve data from the database, validate it through visual nearest-neighbor comparison and inspection, schedule an objective analysis and finally view the streamline and isotach contour plot or any other products derived from the wind field. The back end consists of two redundant database and analysis servers, one of each located at AOML and at NHC, in the likely event of a hurricane landfall in South Florida or during periods of heavy use (Figure 1).

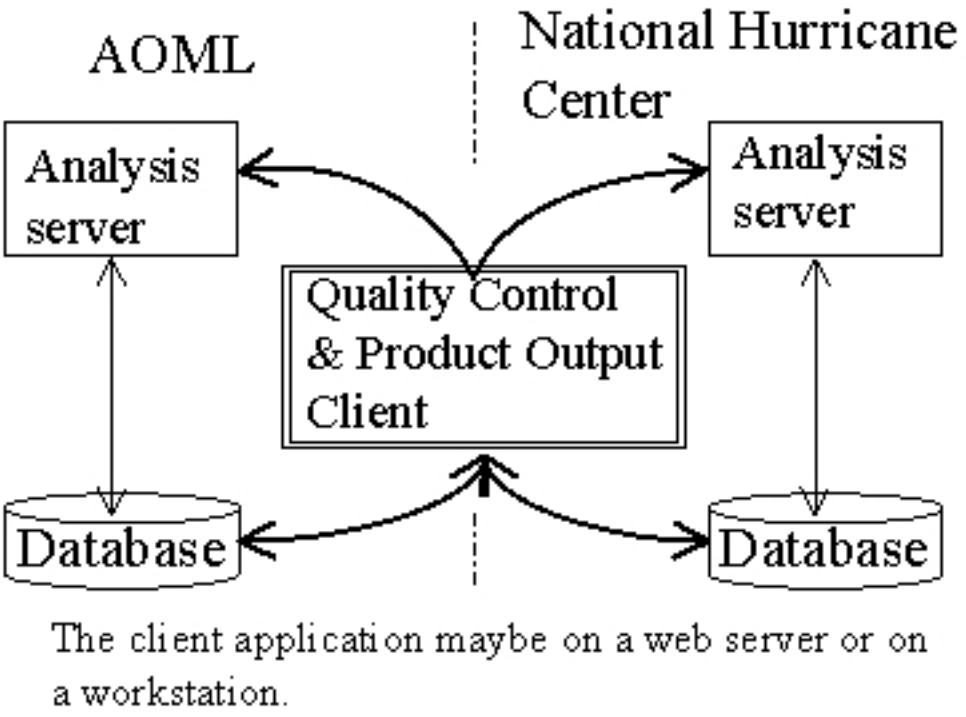

*Figure 1. H*WIND general Internet overview.*

2.1 QUALITY CONTROL

A Quality Control client starts up with two windows: one is mainly responsible for showing the geography and data selected by the user so far, and the other is responsible for the actual selection/creation of the relevant data. The data involved for an analysis is a combination of wind observations and storm track fixes which can be retrieved from either the aforementioned databases or from flat files used by this application's predecessor (for backward compatibility). The existence of a database allows the user to query observations for any specific time span and platform data source, and to query storm fixes or complete tracks for a certain event. Events are created by the user as they arise in nature and are stored in the database to avoid duplication. The user has the capability to set transformations from one event to another, as it happens, for example, when a tropical storm event becomes a hurricane event. Automatically, this environment provides both a real-time (operational) and post storm (research) modes. Moreover, during a real-time session, the user can easily check for any new wind data that might have arrived since a previous load time. Nevertheless, as a means to ensure a well confined data set, all extraneous observations to the current basin are ignored.

From the map window, users are offered various tools to facilitate their quality control tasks: zoom in/out, geographic location and distance, wind observation group flagging/unflagging (designate them to be failed or undo), and datum inspection and edition panels. The user can also choose a synoptic or storm-relative view of the data. Optionally, the user may load landmark and shape files, which would be superimposed on the map similar to a Geographic Information System (GIS) software.

2.2 ANALYSIS

Once the user has finished evaluating a data set, he may schedule an analysis where only the passed and edited (user changes of certain attributes) wind observations are considered as well as the current loaded storm track with its modifications.

After the user chooses some specific parameters, such as type of analysis (wind, pressure, temperature or relative humidity) and storm size, the quality controlled data set is committed (that is, permanent changes on data are executed as a whole) to the database. Simultaneously, the actual analysis algorithm is invoked, whose results not only will be committed to the database but also associated to its corresponding data set, for total cross-reference.

Due to the fact that the analysis code was written in FORTRAN by in-house expert meteorologists, it is limited to run on a specific architecture; thus the need of dedicated servers. But this code has been converted into libraries loadable in Java, and therefore, with the use of object distribution technology, the analysis can be requested from any Quality Control client in a transparent manner to the user.

2.3 PRODUCT GENERATION

This subsystem is the least platform independent so far, as it depends on a commercial visualization software being installed on the client side. While the analysis committal is undergoing, a separate process thread will feed the current analysis results to scripts of this software to generate various products, such as streamline and isotach plots (Figure 2), wind swaths, gridded data and any other products that could benefit forecasters, emergency managers and the scientific community in general. The output will be made available in shapefiles and netCDF format for input on GIS programs and National Weather Service's AWIPS (Advanced Weather Interactive Processing System).

Work is on the way, though, to perform H*WIND's product generation on a server, probably the same server as the Analysis for efficiency purposes. Consequently, product demand will also comply with the goal of being accessible over the Internet from any Quality Control client.

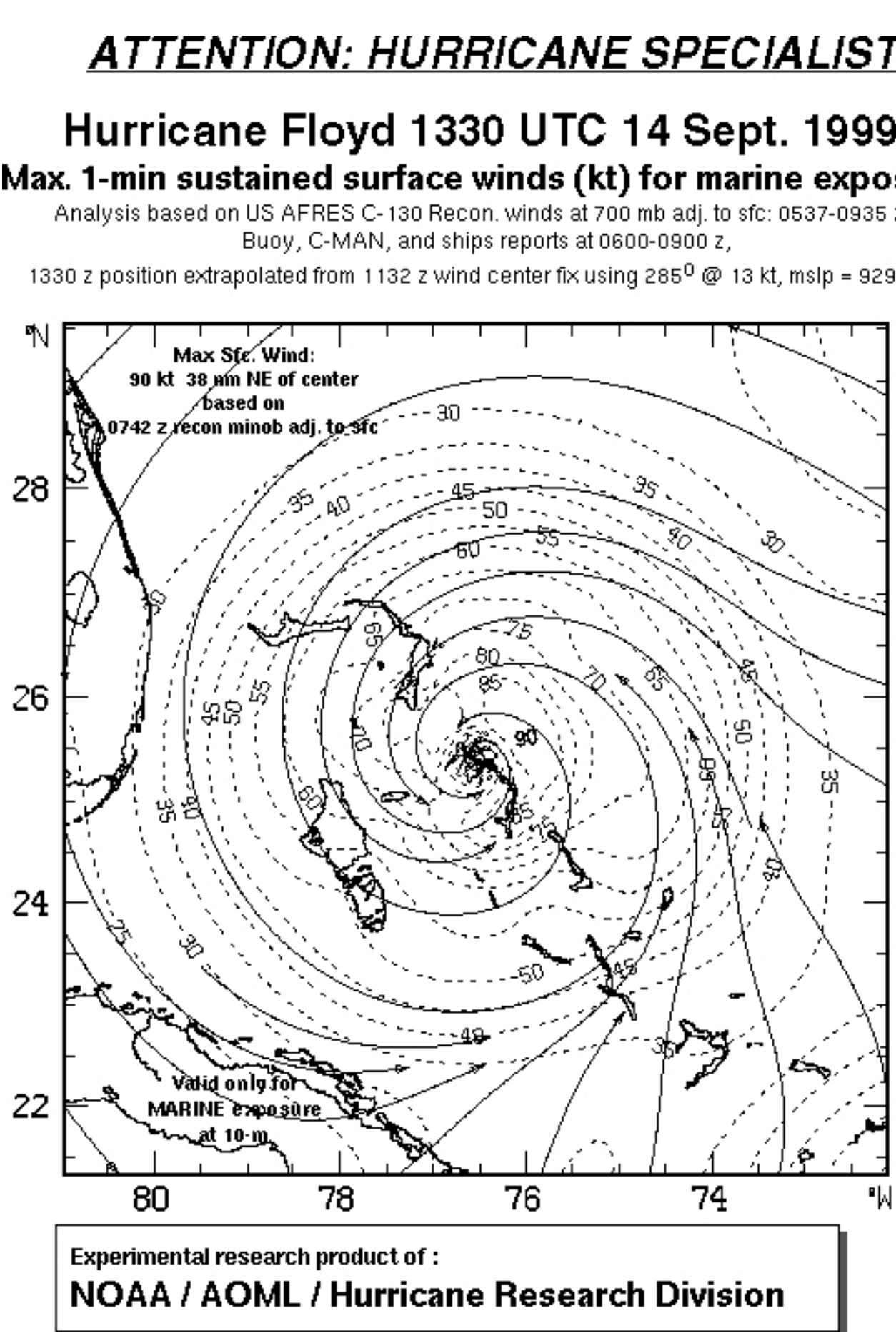

Figure 2. Example of a streamline and isotach plot.

3. REFERENCES

Amat, Jr., L. R., M. D. Powell, S. H. Houston, and N. Morisseau-Leroy, 1998: WANDA: HR's real-time tropical cyclone wind analysis distributed application. 14th Conference on Interactive Information and Processing Systems, Phoenix, AZ, January 11-16, Amer. Meteor. Soc.

Powell, M. D., Houston, S. H., Amat, Jr., L. R., and Morisseau-Leroy, N., 1997: The HRD real-time hurricane wind analysis system. 8th Preprints 24th Conference on Hurricanes and Tropical Meteorology, Ft. Lauderdale, American Metereological Society, 197-198.

Amat, Jr., L. R., M. D. Powell, S. H. Houston, 1999: A real-time Internet based application for the archival, quality control and analysis of hurricane surface wind observations. 15th International Conference On Interactive Information and Processing Systems for Meteorology, Oceanography, and Hydrology, January 10-15, Dallas, TX.

Morisseau-Leroy, N., 1997: Atmospheric observations, analyses, and the World Wide Web using a semantic database, Master of Science Thesis, School of Computer Sciences, Florida International University, Miami, FL.

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